"Express Mail" mailing label number EL 835293519 US

Date of Deposit: December 6, 2001

Patent

Case No.: 10200/1411

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN THE APPLICATION OF:
James M. Cleeves

Group Art Unit: 1645

Appl. No.: 08/581,347

Examiner: G. Portner

Filed: December 29, 1995

For: WAFER TEMPERATURE CONTROL APPARATUS AND METHOD

APPLICANT'S BRIEF IN SUPPORT OF THE APPEAL TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

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I. REAL PARTY IN INTEREST

The real party in interest is Cypress Semiconductor Corp.

II. RELATED APPEALS AND INTERFERENCES

There are no other related appeals or interferences.

III. STATUS OF CLAIMS

Claims 1-20 have been cancelled. All of the pending claims, claims 21-43, have been finally rejected and are appealed.

Claims 21-27, 29, 31-37, 40, and 41-43 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent 5,096,536 (the '536 patent) to *Cathey Jr.* Claims 28 and 21 and 30 are rejected under 35 U.S.C. § 103(a) as being obvious over *Cathey Jr.* in view of U.S. Patent 5,089,880 (the '880 patent) to *Meyer et al.* or U.S. Patent 4,931,135 (the '135 patent) to *Horiuchi et al.* Claims 38 and 39 are rejected under 35 U.S.C. § 112 as being incomplete for omitting essential steps.

IV. STATUS OF AMENDMENTS

Applicant has filed no amendments subsequent to the final rejection.

V. SUMMARY OF THE INVENTION

The present invention relates to a semiconductor wafer processing method. (page 1, line 4). Typically, semiconductor wafers are inserted in a vacuum chamber and subjected to plasma discharge to etch the wafer's surface. (page 1, line 10). During this etching process, the temperature of the wafer

increases; because wafer temperature and etching rate are proportional, as the temperature of the wafer increases, so does the etching rate. (page 2, lines 13-14). A heat transfer gas, such as helium, is introduced between the wafer and the lower electrode to transfer heat from the wafer; this prevents the wafer from overheating. (page 2, lines 19-24). A seal resides between the wafer and the lower electrode, which prevents the heat transfer gas from escaping into the vacuum chamber; if the heat transfer gas leaks into the vacuum chamber, the resultant reduction in vacuum could adversely affect the etching process. (page 7, lines 16-17; page 10, lines 20-21).

Etching may become uncontrollable unless a substantially uniform temperature is maintained across the wafer; while heat must be removed from the wafer to prevent overheating, if this cooling process results in temperature differentiation across the surface of the wafer, the relatively hotter portions of the wafer will be more deeply etched than the cooler portions. (page 2, lines 14-18). The present invention maintains substantially uniform heat transfer across the wafer; for example, a seal having a thermal conductivity closely matched to that of the heat transfer gas may be used. (page 7, lines 26-37; page 8, lines 1-2). By transferring heat from the wafer in a substantially uniform manner, temperature differentiation between selected portions of the wafer is minimized; therefore, etching uniformity is enhanced. (page 2, lines 15-18)

VI. ISSUES

The issues to be decided on this appeal are as follows:

1. Whether claims 21-27, 29, 31-37, 40, and 41-43 are anticipated by *Cathey, Jr.*

2. Whether claims 28 or 21 and 30 are obvious over *Cathey Jr.* in view of *Meyer et al.* or *Horiuchi et al.*

3. Whether claims 38-39 are incomplete for omitting essential steps.

VII. GROUPING OF CLAIMS

The pending claims do not stand or fall together. Each claim is independently patentable. Arguments as to the independent patentability of each claim are presented below.

VIII. ARGUMENT

The present invention alleviates the problem of uncontrollable or uneven semiconductor wafer etching by transferring heat substantially uniformly across a substrate. While the overall rate of heat transfer from the substrate is important and occurs simultaneously with transfer across the substrate, Applicant's invention is directed to reducing temperature differences between portions of the substrate, not enhancing overall heat transfer from the substrate. In the past, differences in etching rates were not very important because of the relatively large feature sizes. However, today, extremely small structures are designed into semiconductor devices, and very small differences in etching rates can dramatically affect the yield of useful devices from a wafer.

The fact that uneven heat transfer across the surface of a wafer or substrate results in uncontrollable or uneven etching is well known. For example, U.S. Patent No. 5,698,070 to *Hirano et al.* (cited on Form 892 with the last Office Action) describes this very problem. (col. 1, lines 26-33). This reference teaches that temperature differences between 10° and 40° Centigrade can exist between the peripheral and center portions of a wafer during etching. (col. 10, lines 1-35). *Hirano* attempted to mitigate this problem through introduction of an auxiliary gas to the peripheral portion of the wafer. (col. 1, lines 40-52).

Applicant's invention addresses the problem of uneven etching by providing a substrate having a substantially uniform temperature during the etching process. For example, the semiconductor wafer or substrate is sealed to the lower electrode with a single sealing ring having a thermal conductivity closely matched to that of the heat transfer gas. In one embodiment, the seal is made from KAPTON when the heat transfer gas is Helium. In this embodiment, closely matching the thermal conductivity of both the seal and the transfer gas, results in a reduction in temperature differences across the surface of the substrate. Since etching rates are proportional to substrate temperature, a substrate having a substantially uniform temperature across its surface during etching yields a substrate with a more uniform depth of etching.

It is important to avoid the easy misconception of the difference between total heat transfer from a substrate verses maintaining a substantially uniform temperature across a substrate. The cited art enhanced total heat transfer from a semiconductor substrate through an improved sealing device. **The cited art**

does not address, or even mention, the uniformity of heat transfer across a substrate. Applicant's invention provides methods to plasma etch substrates having substantially uniform temperatures. It is not about improved sealing devices or increased total heat transfer rates.

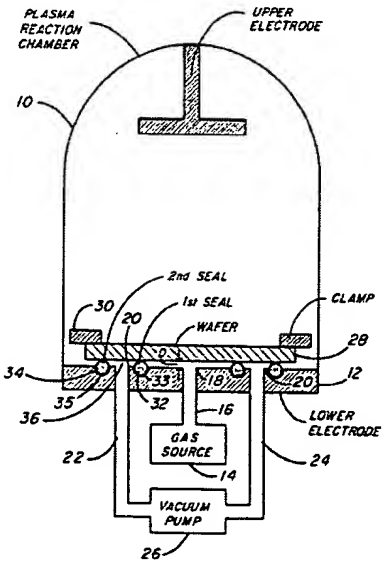
Although failing to meet any of the legal requirements for an inherency rejection, the Examiner interpreted the absence of Applicant's limitation from the art as proof that it was inherent. To sustain an inherency rejection the Examiner must provide a basis to reasonably support that the allegedly inherent characteristic **necessarily** flows from the art **and** that one of skill in the art would recognize such. The Examiner provided no factual basis or technical reasoning that the art maintained a substantially uniform temperature across the substrate. Neither did the Examiner provide any suggestion that such a limitation would be recognized by one of skill in the art. The Examiner's rejection, rooted in the doctrine of inherency, is unsustainable because neither the cited art, nor the Examiner, provided the requisite basis.

A. *Cathey Jr.* Fails To Anticipate Applicant's Claims Because Every Limitation Is Not Taught.

In the March 13, 2001 Final Rejection, the Examiner reasserted the same 35 U.S.C. § 102 rejection under *Cathey Jr.* as relied on in paragraphs 8 and 9 of prior paper 21. This rejection was maintained in spite of Applicant's October 2000 telephone interview and detailed, illustrative response of December 20, 2000 explaining the technology. The language of the final rejection demonstrates a misconception of the difference between heat transfer from a substrate verses maintaining a substantially uniform temperature across a substrate.

Cathey Jr. is directed to enhancing heat transfer from a semiconductor substrate by "greater-than-ever-before-possible differential pressures" between the top and bottom surfaces of the substrate through enhanced "sealability." (col. 3, lines 1-2; col. 2, line 64). By increasing the pressure of the cooling gas below the substrate in relation to previous pressures, *Cathy Jr.* allows for an increased rate of heat transfer between the substrate and the lower electrode. (col. 4, line 65). This increased rate of total heat transfer **away from** the substrate does not address the uniformity of heat transfer **across** the substrate.

The benefit of *Cathey Jr.* is accomplished by two seals bounding an evacuated area. (col. 5, lines 22-23). The purpose of *Cathey Jr.*, as clearly stated in column 2, lines 64 and 65, is to improve the seal between a substrate and its underlying supporting electrode, thus reducing cooling gas loss into the plasma reaction chamber. This purpose is evident in the illustration from *Cathey Jr.* below.



Although *Cathey Jr.* addresses heat transfer from the substrate wafer, there is nothing indicating concern for uniformity of heat transfer across the wafer, or differential etching rates which result from non-uniformity of the temperature across the wafer. This problem exists in the systems of *Cathey Jr.*, as demonstrated by U.S. Patent No. 5,698,070 (col. 1, lines 26-33). Furthermore, *Cathey Jr.* indicates that vacuum is a poor heat transfer path (col. 2, lines 15-20); thus, inclusion of a vacuum region should be detrimental to uniform heat transfer across the wafer. (It is important to note that while the **total** heat transfer from the wafer may be sufficient to keep the *Cathey Jr.* wafer from overheating; the temperature difference between parts of the wafer may nonetheless be large.)

Applicant realized that to improve etching homogeneity, the uniformity of heat transfer across the substrate was at least as important as the rate of heat transfer from the substrate. Thus, Applicant's invention is not about improved sealing, nor increased heat transfer rates. Instead, Applicant addresses the problem of the uniformity of heat transfer across the substrate.

As an example, applicant achieves substantially uniform heat transfer across the substrate by relying on a single O-ring type seal with a thermal conductivity closely matched to that of the cooling gas. The high differential pressures between the top and bottom surfaces of the substrate, which are the essence of *Cathey Jr.*, are not relevant to the problem with which Applicant was concerned: uniform temperature across the substrate.

While the Federal Circuit clearly held in In re Spada, 911 F.2d 705, 709, 15 U.S.P.Q. 2d 1655 (Fed. Cir. 1990) that to be anticipated, the prior art reference must contain each and every element of the claimed invention (MPEP § 706.02), the Examiner persists in maintaining that *Cathey Jr.* somehow anticipates Applicant's claims. In fact, there is no description or suggestion in *Cathey Jr.* that the etching system results in substantially uniform heat transfer across a substrate. There is no teaching that the thermal conductivity of the heat transfer gas and the seal may be matched to achieve a substantially uniform substrate temperature. *Cathey Jr.* cannot teach such a matching because the multi-component seal described includes a region of vacuum – an exceptionally poor heat conductor – between the two O-rings. Transferring heat substantially uniformly across a substrate where the substrate has a substantially uniform temperature clearly differentiates the current invention from *Cathey Jr.*

1. Applicant's invention is not a device.

Since Applicant's substantially uniform thermal conductivity limitation clearly prevents *Cathey Jr.* from anticipating Applicant's claims, the Examiner attempted other ways of finding this limitation in the reference. The first attempt essentially redefined Applicant's invention as a device so the Examiner could attempt to apply "structural" based rejections (paper 24, page 4). However, Applicant does not claim a device. The claimed invention is neither a device, nor a structure, but a method of plasma etching a substrate having a substantially uniform temperature.

The Examiner's argument, that "[n]o structural limitations are recited in the claims that define the instant invention over that disclosed and taught in the prior art," simply elucidates a misunderstanding of the technology at hand. (paper 24, page 4). Applicant freely concedes that there may be no visible difference between one O-ring seal and another. However, the thermal conductivity and other physical properties of a material is a structural characteristic every bit as distinguishing as its size or shape. The Examiner cannot reject Applicant's claimed invention by casting the methods as a device and ignoring the limitation of substantially uniform heat transfer. This limitation as to how the method is practiced must be considered; it cannot be ignored.

2. The Examiner failed to meet the legal requirements for finding elements by inherency.

The Examiner's second attempt to find Applicant's limitations appears based in the doctrine of inherency. (paper 21, page 5; paper 24, page 4). To sustain a rejection under the doctrine of inherency, two requirements must be met. First, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic **necessarily** flows from the teaching of the prior art. Ex parte Levy, 17 USPQ2d 1461, 1464 (B.P.A.I. 1990) (emphasis in original); M.P.E.P. § 2112. Second, for a limitation to be inherent, the function must be present in the prior art and must be recognized by one of ordinary skill in the art. In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999); M.P.E.P. § 2112. The Examiner has failed on both accounts.

The Examiner has provided no factual basis or technical reasoning that Applicant's substantially uniform heat transfer across the substrate **necessarily** flowed from the sealing methods of *Cathey Jr.* The reason the Examiner can provide no such factual basis or technical reasoning is that *Cathey Jr.* never mentions or even alludes to heat transfer across the substrate. In fact, as previously discussed, *Hirano* describes the very problem of non-uniform heat transfer across substrates in systems similar to that in *Cathey Jr.* Thus, because *Cathey Jr.* fails to disclose uniform heat transfer, and because other art establishes that it is in fact non-uniform temperatures which are observed in a system such as *Cathey Jr.'s*, uniform heat transfer could not have **necessarily** flowed from the reference. The Examiner cannot parlay the fact that a reference is silent on a topic (substantially uniform heat transfer across the substrate) to establish that such a property is inherent to the reference.

Additionally, the Examiner has failed to establish that Applicant's substantially uniform heat transfer limitation was present in *Cathey Jr.* and would be recognized by one of ordinary skill in the art, as required by *Robertson*. It is impossible for the Examiner to meet this requirement because heat transfer would not be expected to be uniform across the substrate of *Cathey Jr.*, in part due to the vacuum created between the seals (a vacuum is known to have very poor heat transfer properties). To sustain an inherency rejection under *Robertson*, the Examiner must show that the sealing methods of *Cathey Jr.*, which allowed for enhanced pressure differentiation, disclose Applicant's

substantially uniform heat transfer across a substrate to one of skill in the art. No such evidence was cited by the Examiner, not even a theory.

Even if substantially uniform heat transfer could have resulted in *Cathey Jr.*, inherency cannot be established by mere probability or possibility. As was held in *Robertson*, the mere fact that a certain thing (substantially uniform heat transfer in the current case) may result from a given set of circumstances is insufficient to sustain an anticipation rejection.

The Examiner's only attempts at supporting the contention that "[t]he reference inherently anticipates the now claimed invention" is that "the Office does not have the facilities for examining and comparing applicant's protein [invention] with the protein [invention] of the prior art." (paper 21, page 5; paper 24, page 4). Without any colorable legal or technical theory, the Examiner placed the burden on the Applicant to show a novel or unobvious difference. However, the burden to show such a difference never shifted to the Applicant because the Examiner failed to provide any factual basis or technical reasoning why substantially uniform heat transfer could have occurred in *Cathey Jr.* Even if the burden had shifted, maintaining a substantially uniform temperature across the substrate is clearly novel and unobvious in view of *Cathey Jr.* because the inventions have different purposes. *Cathey Jr.* enhanced heat transfer while Applicant enhances heat transfer uniformity. *Cathey Jr.* never even suggested a solution to the problem solved by the present invention.

As in *Levy*, the Examiner has wholly failed to provide any objective evidence or cogent technical reasoning to support the conclusion of inherency.

Levy, 17 USPQ2d at 1464. Because the examiner has been unable to provide any recitation or suggestion that *Cathey Jr.* practiced substantially uniform heat transfer across the substrate, the § 102 rejection is unsustainable. The Examiner cannot assume that Applicant's claim limitations are met without the proffer of any evidence. A reference's silence on a subject fails to establish its inherency.

B. The Combination of *Cathey Jr.* with *Meyer et al.* or *Horiuchi et al.* Does Not Make The Claimed Invention Obvious.

The Examiner cited *Meyer et al.* and *Horiuchi et al.* to supply the elements of Applicant's dependent claims. Since neither of these references teach substantially uniform heat transfer across a substrate, the claimed invention can be neither anticipated nor obvious over the applied references. In fact, the secondary references are silent on the uniformity of heat transfer across the semiconductor substrates. Thus, the cited references could not make Applicant's claims obvious because the references fail to provide the limitations of Applicant's claims.

Furthermore, the Examiner has failed to provide a motivation to combine the references or a reasonable likelihood of success as required under In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991) for a sustainable obvious rejection. (M.P.E.P. § 2143). Neither *Cathey Jr.*, *Meyer et al.*, nor *Horiuchi et al.* provides a suggestion that a substrate should be etched while the substrate has a substantially uniform temperature. Likewise, the references do not provide the requisite reasonable likelihood that etching under such circumstances could successfully result in more uniform etching. The Examiner proffers no other motivation for combining the references. Because the

references fail to provide any motivation that they should be combined, or that their combined teaching would result in some desirable outcome, the obviousness rejection should be reversed.

Claims 41-43 of the current invention are further distinguished from the applied references. These claims specify that only one seal resides between the substrate and the support surface. Since *Cathey Jr.* requires two annular regions, one under vacuum and one filled with a heat transfer gas, at least two seals are required. The combination of *Cathey Jr.* with *Meyer et al.* or *Horiuchi et al.* fails to teach or suggest Applicant's substantially uniform heat transfer. In fact, the combination teaches toward a multiple seal method and, therefore, away from the invention of claims 41-43. Accordingly, these claims are neither anticipated nor obvious in view of the cited art. Thus, the rejection should be reversed.

C. Claims 38-39 Satisfy The Essential Step Requirement Because They Contain Every Step Described As Essential To The Invention.

The Examiner rejected claims 38-39 as incomplete for omitting essential steps under 35 U.S.C. § 112 on the theory that they state how to produce a semiconductor structure, but fail to recite the steps required to make a semiconductor or an electronic device. However, such an enablement rejection is only proper when the claims omit matter "disclosed to be essential to the invention." In re Mayhew, 527 F.2d 956, 189 USPQ 266 (CCPA 1968); (M.P.E.P. § 2172.01).

The "omitted" claim parts referred to by the Examiner, how to make a semiconductor or electronic device by the claimed etching method, are not

described as essential anywhere in the specification. This is because such procedures are well known to those of ordinary skill in the art and because Applicant's invention addresses a novel wafer etching method, not circuit design. Any parts that may be described as essential in the specification are included in claim 21, from which claims 38-39 depend. The rejection is unsustainable and should be reversed because the claims do not omit steps described as essential by the specification.

D. The Claims Are Independently Patentable.

Independent claim 21 focuses on a method of making a semiconductor structure where the surface of a substrate is etched. The heat from etching is transferred substantially uniformly across the substrate to a seal and a gas that contact the substrate. The Examiner was unable to find any art disclosing a method in which heat was uniformly transferred across the substrate during etching.

Each of the claims depending from claim 21 provide additional limitations not found in the independent claim from which they depend. Depending from independent claim 21, claim 22 provides detail regarding how the substrate is sealed to a support surface which allows for gas entry. Claim 23 adds a clamp engaging the surface of the substrate. Claim 24 provides a preferred seal thickness. Claim 25 provides a preferred seal shape. Claim 26 requires that the space created between the substrate and the support surface is substantially airtight. Claim 27 provides a preferred seal width. Claim 28 provides a preferred substrate thickness. Claim 29 provides a preferred heat transfer gas. Claim 30

provides a preferred seal material. Dependent claim 38 provides a method of making a semiconductor devices incorporating the etching method of claim 21. Claim 39 provides a method of making an electronic device from the semiconductor device of claim 38. Finally claim 41 limits the method of claim 21 to a single seal between the support surface and the substrate. Each invention is separate and independently patentable.

Unlike independent claim 21, independent claim 31 is a means-plus-function claim where the means for providing substantially uniform heat transfer across the substrate is limited to the specific structures and their equivalents provided in the specification. The Examiner was unable to provide any art addressing the types of structures which may be used to provide substantially uniform heat transfer across the substrate during etching.

Each of the claims depending from claim 31 provides additional limitations not found in independent claim 31. Dependent claim 32 provides specific structures, including a seal, a gas, a support surface, and their arrangement with respect to each other that may be used in the claim 31 method. Claim 33 describes the assembly for holding the substrate during etching which includes the aperture for introducing a gas. Claim 34 provides a preferred shape for the seal. Claim 35 provides that the space created between the substrate and the support is airtight. Claim 36 provides a preferred heat transfer gas. Finally claim 42 limits the means for providing substantially uniform heat transfer across the substrate to a single seal between the support surface and the substrate. Each invention is separate and independently patentable.

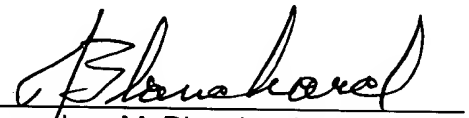
Unlike independent claims 21 and 31, which address how substantially uniform heat transfer across the substrate is accomplished, independent claim 37 focuses on a method of plasma etching a semiconductor structure having a substantially uniform temperature. This differs from the prior independent claims because the focus is on the substrate and not the heat removal structures. The Examiner was unable to provide any art addressing plasma etching a substrate having a substantially uniform temperature.

Finally, independent claim 40 is in the Jepson format and describes a substrate etching method using a lower electrode and a gas, wherein the improvement comprises a seal that provides substantially uniform heat transfer across the substrate. Unlike the prior independent claims, independent claim 40 focuses on the seal. The Examiner was unable to provide any art addressing a seal which could be used to transfer heat in a substantially uniform manner across a substrate during plasma etching. Dependent claim 43 provides that the seal addressed in claim 40 is a single seal residing between the lower electrode and the substrate. Each invention is separate and independently patentable.

IX. CONCLUSION

For the foregoing reasons, the claim rejections applied by the Examiner are unsustainable. The Examiner has failed to establish even a colorable theory on which to maintain either the anticipation or obvious rejections. Applicant respectfully requests reversal of the Examiner's rejections.

Respectfully submitted,



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APPENDIX

21. A method of making a semiconductor structure, comprising:

plasma etching a surface of a substrate; and

transferring heat from said substrate to (i) a seal on a support surface, and (ii) a gas in a space defined by said substrate, said seal and said support surface, substantially uniformly across said substrate, said seal being in contact with an opposing surface of said substrate.

22. The method of Claim 21, wherein said substrate is held in an assembly, said assembly comprising

a holding body having said support surface, said holding body having an aperture for passing therethrough said gas, and

wherein said seal has an inner peripheral portion defining an opening for receiving said gas.

23. The method of Claim 22, wherein said assembly further comprises a clamp frictionally engaging said surface of said substrate.

24. The method of Claim 21, wherein said seal has a thickness of 25 to 125 microns.

25. The method of Claim 21, wherein said seal has an outer peripheral portion with a shape substantially conforming to a shape of an outer peripheral portion of said substrate.

26. The method of Claim 22, wherein said space is substantially airtight.

27. The method of Claim 21, wherein said seal has a width of approximately 3 to 4 mm.

28. The method of Claim 21, wherein the substrate has a thickness of approximately 25 to 125 microns.

29. The method of Claim 21, wherein said gas comprises helium.

30. The method of Claim 21, wherein said seal comprises the generic material from which Kapton is made.

31. A method of making a semiconductor structure, comprising:

a step for etching a surface of a substrate;

wherein said substrate is in contact with means for providing substantially uniform heat transfer across said substrate.

32. The method of Claim 31, wherein said means comprises a seal, a gas and a support surface, said seal is between said substrate and said support surface, and in contact with said substrate and said support surface,

said substrate, said seal and said support surface defining a space,

said gas is in said space, and

heat transfer through said seal and said first gas provides said substantially uniform heat transfer across said substrate.

33. The method of Claim 31, wherein said substrate is held in an assembly,

said assembly comprising

a holding body a support surface, said holding body having an aperture for passing therethrough a gas.

34. The method of Claim 32, wherein said seal has an outer peripheral portion with a shape substantially conforming to a shape of an outer peripheral portion of said substrate.

35. The method of Claim 32, wherein said space is substantially airtight.

36. The method of Claim 32, wherein said gas comprises helium.

37. A method of making a semiconductor structure, comprising:

plasma etching a surface of a substrate;

wherein said substrate has a substantially uniform temperature.

38. A method of making a semiconductor device, comprising:
making a semiconductor structure by the method of Claim 21; and
making a semiconductor device comprising the semiconductor structure.

39. A method of making an electronic device, comprising:
making semiconductor device by the method of Claim 38; and
making an electronic device comprising the semiconductor device.

40. In a method of making a semiconductor structure, including plasma etching a substrate, wherein the substrate is on a lower electrode, and a gas is fed through the lower electrode toward the substrate, the improvement comprising a seal between the substrate and the lower electrode having a heat conductivity providing substantially uniform heat transfer across the substrate.

41. The method of Claim 21, wherein said seal is the sole seal between said support surface and said substrate.

42. The method of Claim 31, wherein said means comprises only one seal.

43. The method of Claim 40, wherein said seal is the sole seal between said lower electrode and said substrate.